

# Contents

Preface to first edition *v*  
Preface to second edition *vii*  
Abbreviations *xiv*

## Environmental chemistry in a global perspective *1*

- 1 Environmental chemistry *3***
  - 1.1 *The subject matter of this book* *5*
  - 1.2 Environmental composition *8*
  - 1.3 Chemical processes *10*
  - 1.4 Anthropogenic effects *14*
    - Additional reading *17*

## The Earth's atmosphere *19*

- 2 The Earth's atmosphere *21***
  - 2.1 The Earth's atmosphere—the air we breathe *21*
  - 2.2 Solar influence on the chemical composition of the atmosphere *24*
  - 2.3 Reactions and calculations in atmospheric chemistry *27*
    - Additional reading *39*
    - Problems *39*
- 3 Stratospheric chemistry—ozone *42***
  - 3.1 Concerns about stratospheric ozone *42*
  - 3.2 Oxygen-only chemistry—formation and turnover of ozone *48*
  - 3.3 Processes for catalytic decomposition of ozone *51*
  - 3.4 Chlorofluorocarbons (CFCs) *56*
  - 3.5 Other reactions involving stratospheric ozone *63*
  - 3.6 Antarctic and Arctic 'ozone hole' formation *64*
    - Additional reading *67*

- Websites—Information on ozone monitoring 68
- Problems 68
- 4 Tropospheric chemistry—smog 71**
  - 4.1 What is smog? 72
  - 4.2 The chemistry of photochemical smog 74
  - 4.3 Exhaust gases from the internal combustion engine 85
    - Additional reading 98
    - Problems 98
- 5 Tropospheric chemistry—precipitation 100**
  - 5.1 The composition of rain 101
  - 5.2 Atmospheric production of nitric acid 104
  - 5.3 Atmospheric production of sulfuric acid 106
  - 5.4 Acidifying agents in precipitation 112
  - 5.5 Rain, snow, and fog chemistry—similarities and differences 113
  - 5.6 The global picture—sources and sinks 116
  - 5.7 Control of anthropogenic nitrogen and sulfur emissions 120
    - Additional reading 123
    - Problems 124
- 6 Atmospheric aerosols 125**
  - 6.1 Sources of aerosols—a closer look 128
  - 6.2 Aerosol concentrations and lifetimes 136
  - 6.3 Air pollution control for particulate emissions 139
    - Additional reading 141
    - Problems 141
- 7 Chemistry of urban and indoor atmospheres 143**
  - 7.1 Pollutants in the urban atmosphere 144
  - 7.2 Mexico City 148
  - 7.3 Indoor air quality 151
  - 7.4 Common indoor air contaminants 153
    - Additional reading 162
    - Problems 162
- 8 The chemistry of global climate 164**
  - 8.1 Composition of the Earth's atmosphere 164
  - 8.2 Energy balance 166
  - 8.3 The greenhouse gases and aerosols 171
  - 8.4 Relative importance of the changes in greenhouse gas concentrations 179
  - 8.5 Energy resources 182
  - 8.6 Greenhouse gases associated with the use of carbon-based fuels 183
    - Additional reading 193
    - Problems 193

**PART B****The hydrosphere** 195

- 9 **The hydrosphere** 197
  - 9.1 Physical and chemical properties of water 201
  - 9.2 Concentration units used for aqueous solutions 208
    - Additional reading 210
    - Problems 210
- 10 **Distribution of species in aquatic systems** 212
  - 10.1 Single-variable diagrams 213
  - 10.2 Two-variable diagrams— $pE$  /  $pH$  diagrams 219
  - 10.3 Measurements of  $pE$  232
    - Additional reading 233
    - Problems 233
- 11 **Gases in water** 236
  - 11.1 Simple gases 237
  - 11.2 Gases that react with water 241
  - 11.3 Alkalinity 246
    - Additional reading 252
    - Problems 252
- 12 **Organic matter in water** 254
  - 12.1 Origins of organic matter in water 255
  - 12.2 Environmental issues related to aqueous organic matter 257
  - 12.3 Humic material 258
    - Additional reading 270
    - Problems 270
- 13 **Metals and semi-metals in the hydrosphere** 273
  - 13.1 Aquo complexes of metals 275
  - 13.2 Classification of metals 278
  - 13.3 Three metals—their behaviour in the hydrosphere 287
  - 13.4 Metal complexes of ligands of anthropogenic origin 293
  - 13.5 Suspended matter in the hydrosphere—metal associations 296
    - Additional reading 297
    - Problems 298
- 14 **Environmental chemistry of colloids and surfaces** 299
  - 14.1 Surface properties of colloidal materials 302
  - 14.2 Quantitative descriptions of adsorption I 308
  - 14.3 Phosphorus environmental chemistry 311

- 14.4 Quantitative descriptions of adsorption II 317
- 14.5 Partitioning of small organic solutes between water and soil or sediment 319
- 14.6 Colloidal material in the natural environment 327
  - Additional reading 333
  - Problems 333
- 15 Microbiological processes 335**
  - 15.1 Classification of microorganisms 336
  - 15.2 Microbiological processes—the carbon cycle 341
  - 15.3 Microbiological processes—the nitrogen cycle 355
  - 15.4 Microbiological processes—the sulfur cycle 361
    - Additional Reading 364
    - Problems 364
- 16 Water pollution and waste-water treatment chemistry 366**
  - 16.1 Water quality guidelines 369
  - 16.2 Waste water and its treatment 373
  - 16.3 Advanced microbiological processes 382
  - 16.4 The final products after treatment of waste water 384
    - Additional reading 385
    - Problems 385



## PART C

### The terrestrial environment 387

- 17 The terrestrial environment 389**
  - 17.1 Soil formation 391
    - Additional reading 400
    - Problems 400
- 18 Soil properties 402**
  - 18.1 Physical properties 402
  - 18.2 Chemical properties 406
  - 18.3 Soil profiles 412
  - 18.4 Environmental issues associated with soils 418
    - Additional reading 430
    - Problems 430
- 19 The chemistry of solid wastes 433**
  - 19.1 Solid wastes from mining and metal production 435
  - 19.2 Organic wastes 440

- 19.3 Mixed urban wastes 448
  - Additional reading 456
  - Problems 457
- 20 **Organic biocides** 459
  - 20.1 What are biocides? 459
  - 20.2 Chemical stability 462
  - 20.3 Mobility of biocides 478
  - 20.4 Leachability 483
    - Additional reading 485
    - Problems 486
- 21 **The future Earth** 488
  - Appendices** 494
    - A.1 Properties of the Earth 494
    - A.2 Area, biomass, and productivity of ecosystem types 495
    - A.3 Properties of air and water 495
    - B.1 The elements 496
    - B.2 Thermochemical properties of selected elements and compounds 499
    - B.3 Mean bond enthalpies  $\Delta H / \text{kJ mol}^{-1}$  at 298 K 501
    - B.4 Dissociation constants for acids and bases in aqueous solution at 25°C 502
    - B.5 Standard redox potentials in aqueous solutions 504
    - C.1 *Fundamental constants* 505
    - C.2 SI prefixes and fundamental geometric relations 505
- Index** 507